Electron-Beam Processing Facility

Unique facility offers wide range of prototype and process development opportunities

Electron-beam processing of materials in a high vacuum is recognized worldwide as being the cleanest, most non-contaminating melting technique available on an industrial scale. Since its inception in the 1950s, electron-beam technology has been used to produce materials ranging from refractory metal alloys to metallic coatings on plastic "jewelry." The ability of E-beams to produce super-pure materials, or to impart unique properties to existing products, has resulted in the continual development of new applications for this technology.

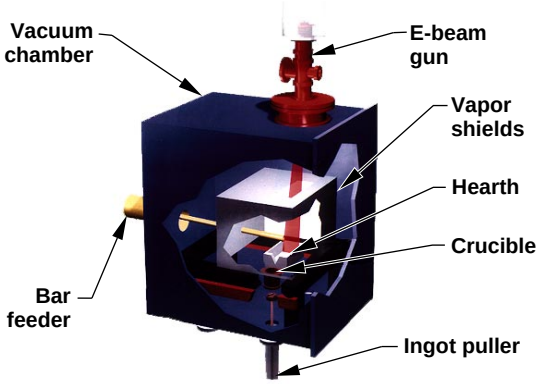
250-kW, state-of-the-art facility

Our technical staff has more than 25 years of experience in electron-beam melting and related processes. We offer a unique combination of design, engineering, modeling, and high-power processing facilities, coupled with a proven capability to respond quickly to customers' needs. The result is a totally integrated R&D package available from few, if any, other research and development organizations in the world.

The large electron-beam processing facility at LLNL uses a 250-kW state-of-the-art electron-beam gun and beam-deflection system with precisely controlled power distribution over a wide range of frequencies and areas. A unique R&D tool, it incorporates diagnostics for heat and mass balance, real-time evaporation rates, and species monitoring. The double differentially pumped electron-beam gun operates over a wide pressure range: 10^{-6} to 10^{-2} Torr. Other smaller systems are available for use in developing processes for both melting and evaporative applications. LLNL's extensive modeling capabilities are also frequently called upon to enhance empirical studies done in the laboratory.

APPLICATIONS

- *Prototype and process development*
- *Basic research and development*
- *Applications lab testing*
- *System and process design*



E-beam melting and casting demonstration furnace.

Melting and refining

Electron-beam melting has been used for many years to recycle low-grade scrap titanium metal. At LLNL, electron-beam cold-hearth melting is being applied in a pioneering waste-minimization effort to recycle scrap uranium metal. The reclamation of other valuable scrap materials offers potentially significant savings in many fields. LLNL's new facilities are in compliance with existing state and federal environmental, health, and safety regulations for processing hazardous, pyrophoric, or radioactive materials. The modular system has a 133-square-inch refining hearth and can operate in many configurations. It can currently produce two-foot-long metal ingots (up to 5.5 inches in diameter) from a variety of feedstock shapes (such as rods, bars, and machining chips).

Process development

We have developed a number of devices and techniques to enhance electron-beam processing. These include compact electron-beam guns with powers in the several-hundred-kilowatt range, and beam-deflection systems with frequencies in the multi-kilohertz range. We have also developed a unique video system that

enables us to monitor (view directly) electron-beam melting and vaporization processes for hundreds of hours at a time in a high-temperature, high-vacuum environment. In addition, exploiting recent advances in solid-state diode-laser technology, we have developed low-cost, highly reliable, vapor-composition sensors based on techniques used in laser-absorption spectroscopy. These sensors have been used successfully for more than 200 hours at a time to control vaporization rates and vapor compositions in high-power runs. They enable us to monitor an alloy's composition and control it in real time. We are developing similar, optical-based technology for controlling liquid levels during continuous-casting operations.

Availability: This technology is available now. We seek collaborative ventures in the field of electron-beam processing—including prototype and process development, basic research and development, applications lab tests, and system and process design consulting.

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